

# Application of LDOS and multipole expansion technique in optimization of photonic crystal designs

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**Abstract** We introduced a procedure of using local density of states for increasing the quality factor and Purcell factor of photonic crystal cavities. We used multipole expansion method for accurate calculation of local density of photonic states, stationary field profile, Q-factor, mode volume and Purcell factor of photonic crystal cavities. We found out that the quality factor exponentially increases with the number of additional photonic crystal layers around the cavity while the mode frequencies stay unchanged. We also demonstrated the method in studying the defect mode's behavior in photonic crystal cavities and showed that high Q-factor, small mode volume and high Purcell factor could be obtained with optimization of geometrical parameters of first neighboring layer.

**Keywords** Photonic crystal cavities · Optimization of geometrical parameters · Local density of states · Quality factor · Purcell factor

## 1 Introduction

Photonic crystals (PCs) are artificially manufactured optical materials that have ability of controlling light propagation and the spatial as well as spectral confinement of photons (Gajic et al. 2004; Zarbakhsh et al. 2007). Thus they have potential to enhance or suppress sponta-

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